THURMOND CHATHAM GAME LAND AQUATIC INVENTORY

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TABLE OF CONTENTS

Introduction....1

Acknowledgements....2

Freshwater Mussels and Sphaeriid Clams....5

Aquatic Snails....13

Crayfishes....23

Freshwater Fishes....38

THURMOND CHATHAM GAME LAND AQUATIC INVENTORY

Introduction

Thurmond Chatham Game Land lies along the eastern slope of the Blue Ridge escarpment in northwestern North Carolina. Located approximately 25 miles northwest of Wilkesboro, the game land is situated in northern Wilkes County with a small portion crossing into Alleghany County. The 6,231-acre tract of land is comprised of 2 disjunct tracts of land, which lie within the Yadkin-Pee Dee River Basin and border the New River Basin. The Yadkin-Pee Dee River Basin drains from above the Virginia border and into South Carolina, crossing the 3 physiographic regions of North Carolina – the Appalachian Mountain Province, the Piedmont Plateau, and the Coastal Plain. This watershed contains 5,900 miles of streams and drains 7,400 square miles, making it the second largest drainage basin in the state. The New River Basin is one of the smaller basins in North Carolina, containing 765 square miles of land area and only 830 stream miles. This river originates on the western slopes of the Blue Ridge and flows northward into Virginia and West Virginia, ultimately draining via the Ohio and Mississippi Rivers to the Gulf of Mexico. The major waterways associated with Thurmond Chatham Game Land include the Roaring River, its three prongs (West, Middle, and East) and their tributaries (e.g., Pike Creek, Cook Branch, Lovelace Creek), Mulberry Creek and its tributaries (e.g., Joshua Creek, Dungeon Creek), and Reddies River and its forks and tributaries. In addition, many waterways that drain into the New River lie within a few miles of the game land. The waterways in this region tend to vary from piedmont-like to mountain-like, with the larger streams tending towards the former and the smaller streams tending towards the latter.

The North Carolina Wildlife Resources Commission (NCWRC) acquired Thurmond Chatham Game Land in 1952 through purchases of many small tracts of land from private landowners. The rugged, mountainous terrain ranges in elevation from 1,400 feet to 3,700 feet and is mostly forested. The dominant forest type is upland oak/hickory, with some cove hardwoods and white and yellow pine. Soil types are mostly of a non-agricultural form, with Ashe loam prominent on the slopes of the higher ridges, Chandler loam occurring on the slopes at intermediate elevations, Talladega loam prominent in the lower slopes, and Congaree type soils occupying the valleys. Initial management activities in the game land concentrated on road improvement to increase access. Over time, habitat management activities were initiated and included such things as planting vegetation for wildlife food, maintaining seeded wildlife openings, and thinning some timber stands. Currently, the management objectives of the NCWRC for Thurmond Chatham Game Land include: 1) providing habitat conditions that maintain or improve the viability of native plant and animal communities, 2) providing hunting, fishing, and trapping opportunities, 3) providing a sustained yield of forest products, and 4) providing opportunities for non-consumptive uses of the game land. White-tailed deer and wild turkey are the 2 dominant big game species on the game land. The property also serves as a black bear sanctuary and supports populations of small game and furbearer species such as gray squirrel, cottontail rabbit, ruffed grouse, wood duck, raccoon, and red and gray fox. In addition, the game land includes numerous streams and ponds that provide fishing opportunities. Given the diverse management objectives of the NCWRC, Thurmond Chatham Game Land attracts a variety of user groups for the purpose of hunting, fishing, bird watching, hiking, and other outdoor activities.

Land use impact in the areas surrounding Thurmond Chatham Game Land appears to be limited given the amount of undisturbed area. A visual survey of the area reveals scattered localities of active crop and pasture lands with some logging. Christmas tree farms seem to be the most dominant land use in the area. Overall, the area adjacent to Thurmond Chatham Game Land is undeveloped, but urbanization does have its effects southward, near Wilkesboro.

The objective of this project was to survey Thurmond Chatham Game Land for aquatic species, including freshwater mussels, sphaeriid clams, aquatic snails, crayfishes, and fishes. Our goals were to determine species presence, distribution, relative abundance, and relative health. Due to the limited number of streams and access points within the game land, the inventory included waterways in and adjacent to the game land within Wilkes, Alleghany, and Ashe counties, North Carolina. Figure 1 and Table 1 detail the localities of all sites surveyed. The following sections provide results of the aquatic inventory for each of the taxa mentioned above. For purposes of this report, *Corbicula fluminea* (Asian clam) was grouped with the sphaeriid clams even though the 2 taxa belong to different families. It also should be noted that any plus or minus symbols listed after road numbers in the following tables represent whether we surveyed upstream or downstream, respectively.

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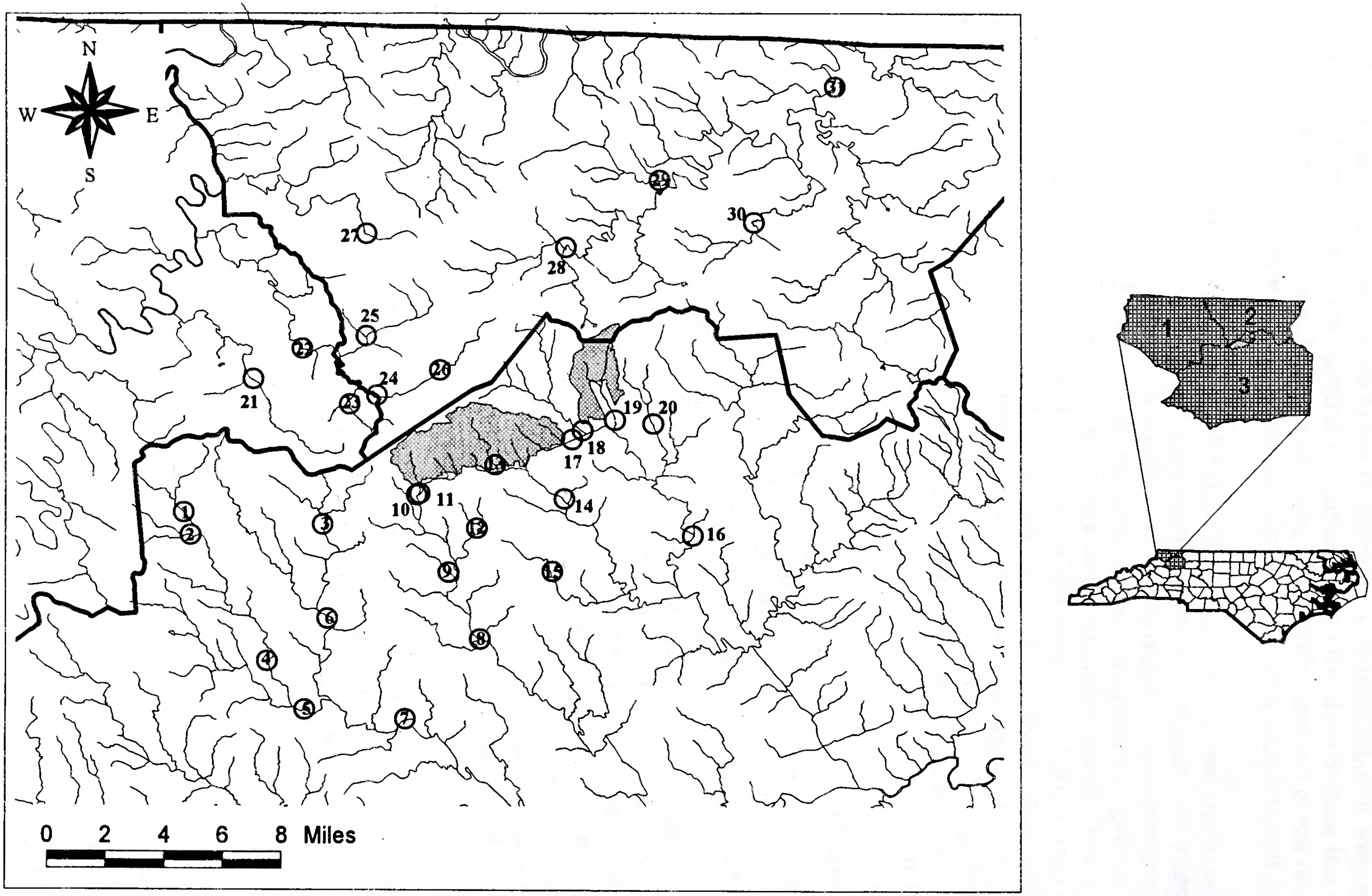

Figure 1. Map of sites surveyed during the aquatic inventory of Thurmond Chatham Game Land, Ashe (1), Alleghany (2), and Wilkes (3) counties, North Carolina, 1999. The location of the game land within the counties, and the location of the counties in the state of North Carolina, are shown to the right.

Table 1. Map numbers, corresponding sites surveyed, and survey effort (person-hours/ electroshock seconds) for the Thurmond Chatham Game Land aquatic inventory (see Figure 1).

Map #	Site Number(s)	Survey effort
1	991019.9btw	1.5
2	991019.10btw, 991028.2btw	1.0/117
3	991021.2btw, 991027.10btw	0.5/162
4	991019.11btw, 991027.8btw	1.0/193
5	991019.12btw, 991027.7btw	1.0/396
6	991019.13btw, 991027.9btw	1.0/173
7	991020.11btw, 991027.6btw	0.67/359
8	991019.14btw	1.0/372
9	991019.15btw	0.5/435
10	991021.6btw	0.5/142
11	991021.1btw	0.5
12	991020.10btw	0.33/184
13	991020.6btw	1.25/119
14	991020.8btw, 991028.1btw	1.0/280
15	991020.9btw	0.5/179
16	991020.7btw	1.0/578
17	991020.5btw	0.75
18	991020.2btw BASin creek	2.5/444secs. (1°15")
19	991020.3btw	1.0
20	991020.4btw	1.5/229
21	991021.3btw, 991028.3btw	0.33/217
22	991019.3btw	2.0/382
23	991019.2btw	1.75
24	991019.1btw	2.5/383
25	991019.4btw	1.5
26	991020.1btw	1.5
27	991019.5btw	1.0
28	991019.7btw, 991028.4btw	0.75/241
29	991019.6btw, 991028.5btw	2.0/433
30	991021.4btw, 991028.6btw	0.67/297
31	991021.5btw, 991028.7btw	0.67/120

10 sites sampled on 10/20/1999

FRESHWATER MUSSELS AND SPHAERIID CLAMS

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Introduction

The freshwater mussel fauna (Bivalvia: Unionoidea), also referred to as unionids or pearly mussels, is an intriguing, diverse, and important group of mollusks. Unionids are often prominent in macrobenthic aquatic communities where, for the most part, they are sedentary filter-feeders. Because unionids consume a major portion of the suspended particulate matter, they provide a number of important roles in aquatic ecosystems, two of which include serving as biological filters and water quality indicators. Mussels also serve as an important dietary component to a number of animals, and economically, their shells provide the nuclei used in the profitable cultured pearl industry (Theil and Fritz 1993). While not as much information has been ascertained for the sphaeriid clams (Bivalvia: Sphaeriidae), also called pea, pill, nut, or fingernail clams, they too serve an important role in aquatic ecosystems as filter-feeders. As part of the inventory of aquatic animals associated with the state-owned Thurmond Chatham Game Land, we conducted field surveys of freshwater mussels and sphaeriid clams found in waterways occurring in and around the game land to better understand the taxonomy, distribution, and conservation needs of the taxa in North Carolina.

Life History

The life cycle of freshwater mussels is an intricate process that is fairly unique when compared to that of other organisms. Spawning begins with the release of sperm from the excurrent aperture of mature males. As the sperm passively drift with the currents, they enter females through their incurrent aperture. Within sexually mature females, fertilization takes place in the suprabranchial cavity, and the resulting embryos are retained in the marsupial gills until they develop into parasitic larvae called glochidia. Glochidia are obligate parasites and must attach to suitable host fishes. Ortmann (1911) described 2 general reproductive modes for unionids based on the length of time that glochidia are retained in the gills of the female. Bradytictic, or long-term brooders, typically spawn in late summer, brood young over the winter, and release mature glochidia during the following spring or early summer. Tachytictic, or short-term brooders, typically spawn in the spring and release mature glochidia sometime during that summer.

Once maturity is reached, the glochidia are released into the water column through the female's excurrent aperture, from specialized gill pores, or by rupture of the ventral portion of the gill (McMahon 1991). Once released by the female, glochidia passively drift with the currents until they attach to suitable host fishes or die. Mechanisms promoting glochidia-fish contact include respiratory, feeding, and spawning activities of fishes, as well as specialized morphologies and behaviors of particular mussel species (Kraemer 1970, Dartnall and Walkey 1979, Zale and Neves 1982). Attachment occurs on the gills, fins, or scales, depending on the mussel subfamily, and is followed by encystment and metamorphosis into juveniles. Metamorphosis generally occurs over a period of 1-3 weeks (Neves 1991) but can last for a few months (Zale and Neves

1982). Once metamorphosis is complete, the juvenile mussel drops from the host fish and settles into the surrounding substrata where, if conditions are suitable, growth until sexual maturity will occur, and the reproductive cycle is repeated.

Unlike unionids, sphaeriid clams are ovoviviparous, self-fertilizing hermaphrodites. All species brood developing embryos in specialized chambers where maternal nutrients are supplied to the embryos. After maturity is reached, the once developing embryos are released into the water column as miniature adults. Due to their relatively large size as mature embryos, compared with other freshwater bivalves (Mackie 1984), most juvenile sphaeriids disperse between drainage systems by clamping their shells onto things such as aquatic insects (McMahon 1991), feathers of waterfowl (Burky 1983), or the limbs of salamanders (Davis and Gilhen 1982) rather than dispersal by water currents. Given highly variable reproductive success rates, sphaeriids typically have 1-3 reproductive efforts per year (McMahon 1991). *Corbicula fluminea* reproduces in much the same manner as sphaeriid clams but tends to use the water currents as its primary means of dispersal (Williams and McMahon 1986). Most populations of the Asian clam have 2 reproductive efforts per year, one in the spring and the second in the late summer (McMahon 1983a).

Habitat Requirements

Freshwater mussels occur in a variety of habitat types, including both lentic (e.g., lakes, ponds, reservoirs) and lotic (e.g., rivers, streams, creeks) systems. Habitat preferences tend to be species specific, with unionids generally being most successful and prevalent in stable, coarse sand or sand-gravel mixtures (Way et al. 1990a). Water velocity also plays a critical role in the distribution, diversity, and abundance of mussel populations. Unionids tend to thrive in conditions where water velocities are low enough to allow for substrata stability, but high enough to prevent excessive siltation (Way et al. 1990a). Water velocity also affects the amount of nutrients carried to the filter-feeding organisms. Chemical parameters such as pH and calcium concentrations can influence the distributions of mussel populations as well. The majority of species prefer alkaline water with a pH above 7.0, but unionids can grow and reproduce over a pH range of 5.6 - 8.3 and can tolerate acidic conditions as low as 4.7 (Okland and Kuiper 1982). Typically, habitats of low pH also have low calcium concentrations. Low calcium concentrations can lead to poor growth and shell dissolution in some individuals, especially if the shell is worn (Kat 1982). Given that growth and dissolution rates are affected by many factors other than pH and calcium concentrations, the minimum tolerable values can vary significantly among habitats. Another important factor to mention in the viability of freshwater mussel populations is the need for suitable host fishes. If the proper host fish is not present for a particular mussel species at any given location, then eventually this species will become extirpated from the site regardless of the habitat conditions.

Sphaeriid clams and Asian clams are generally more tolerant than unionids of what we consider to be harsh conditions. Unlike many unionids, the diversity and abundance of some *Pisidium* and *Sphaerium* species are inversely correlated with substrata size (Kilgour and Mackie 1988), which may be associated with sediment organic feeding mechanisms. *C. fluminea* has a much broader substrata range, and has been seen to successfully colonize habitat consisting of bare rock outcrops to habitat with high silt loads. The highest abundances of *C. fluminea* in North Carolina are often associated with sandy disturbed habitats or with lotic habitats below dams

(J.M. Alderman, NC Wildlife Resources Commission, pers. comm.). Sphaeriids have the ability to colonize ponds and lakes where the depth is greater, the flow is negligible, and the sediment and organic loads are high. Again, this may be associated with feeding mechanisms in sphaeriid clams. Chemical parameters such as pH and calcium concentration regulate sphaeriid clams and *C. fluminea* populations in much the same manner that they affect unionid populations.

Taxonomy, Distributions, and Statuses

Freshwater mussels are represented worldwide, with North America containing the largest collection - 297 currently recognized species and subspecies (Williams et al 1993). While unionids are distributed across the entire continent, the greatest diversity lies within the southeastern United States (Neves et al. 1997). North Carolina's share of this diversity is impressive. Once our taxonomic understanding is more complete, approximately 70 species are expected to occur in our state. A significant amount of literature describing site locations for unionids across North America has led to a more refined understanding of the distribution and taxonomy of this fauna.

Of the 297 recognized taxa of freshwater mussels in North America, Williams et al. (1993) recommended that 213 (72%) be considered endangered, threatened, or of special concern. Nearly half of North Carolina's freshwater mussel species are state listed as endangered, threatened, or special concern, and approximately 30% have undetermined statuses (J.M. Alderman, NCWRC, pers. comm.).

Sphaeriid clams are widely distributed and are represented in North America by approximately 37 species. In North Carolina, there are approximately 13 species (Adams 1990). No species is currently listed at this time.

Anthropogenic effects, such as siltation, riparian habitat destruction, impoundments, pollution, and hydrologic regime alteration are negatively affecting these taxa. With the introduction of exotic species, such as *C. fluminea*, and the impending introduction of *Dreissena polymorpha* (zebra mussel), the situation continues to worsen. Therefore, it is crucial that nongame biologists continue to gather information pertaining to these organisms so proper management plans can be implemented.

Methods

The freshwater mussel and sphaeriid clam survey of Thurmond Chatham Game Land was conducted during the fall of 1999. The game land, located in Wilkes and Alleghany counties, North Carolina, encompasses 6,231 acres. Refer to the Report Introduction for details on history of land use, drainage basin and waterway descriptions, and a map of all the sites that were surveyed. Waterways were accessed at bridge crossings or from roads running alongside rivers. We generally sampled upstream for an arbitrary distance (usually about 30 minutes of walking), until we felt that we had covered most habitat types present. Typical distances were 100 - 400 meters.

Freshwater mussels were surveyed using a variety of techniques depending on the conditions of the site being surveyed (e.g., water depth, visibility, substrata types). In areas where water

clarity allowed, freshwater mussels were surveyed by viewing the substrata through the water surface with the naked eye. These areas also were surveyed with a view scope depending on the depth of the water. In areas that were turbid, freshwater mussels were surveyed by tactilely surveying suitable habitat. Freshwater mussels also were surveyed by sieving the substrata through a dip net. The visual search (naked eye and view scope) was the most prevalent search technique utilized due to the conditions of the waterways associated with the game land.

Sphaeriid clams were collected using a variety of methods, including dip netting, and tactile and visual searches. The most prevalent method used was dip netting. This involved running a dip net through vegetation and the substrata to search for the clams. All specimens collected were preserved in 70%-denatured ethanol and identified according to Burch (1975). Specimens also were sent to Dr. Gerald L. Mackie, University of Guelph, Ontario, Canada, for identification confirmation. All common and scientific nomenclature follows Turgeon et al. (1998).

Results

Over 3 days from 19 to 21 October 1999, 31 sites were inventoried and freshwater mussels were not collected or observed in any of the waterways associated with Thurmond Chatham Game Land. Over the same time period and at the same localities, sphaeriid clams were collected at only 1 site (Table 2). A single shell of *Sphaerium striatinum* (striated fingernailclam) was present at site 27 (see Figure 1).

Discussion

The overall diversity of the freshwater mussel fauna in Thurmond Chatham Game Land and its associated waterways is low. The surveyed waterways of the Yadkin-Pee Dee River Basin didn't provide habitat for any of the 13 species noted by Johnson (1970) as being present in this drainage area. Likewise, the surveyed waterways of the adjacent New River Basin provided habitat for none of the 3 unionid species noted by J.M. Alderman (NCWRC, pers. comm.) or McGrath (1998) as being present. Current distribution patterns and ranges of the sphaeriid fauna are much less understood than those for the freshwater mussel fauna. However, the location of a single sphaeriid shell is a clear indicator that the diversity and abundance of these clams also are low for the game land and its associated waterways.

The water body types that we encountered during our survey ranged from piedmont-like to various sized mountain streams. Given the wide range of available habitats, one might have expected the presence of freshwater mussels since they are typically more successful in areas with diverse habitat types (see Background, Habitat Requirements). Additionally, sedimentation did not appear to be having a significant impact (over the surveyed area) resulting in the absence of unionids. Likewise, while the diversity and abundance of some sphaeriid species are inversely correlated with substrata size (Kilgour and Mackie 1988), it was expected that we would find more than a single clam shell. Many factors could have contributed to the absence of unionids and the negligible presence of sphaeriids, but the most likely factor is the influence of geomorphology and topography. Major landscape scale factors such as these are known to influence and impact the distribution and abundance of organisms over time, and it is possible that the area we surveyed is naturally devoid of freshwater mussels and pea clams. In support of this thought, McGrath (1996) also noted that no unionids were present in Stone Mountain State

Park, which is located just east of the area we surveyed. McGrath also noted (NCWRC, pers. comm.) that no sphaeriids were collected during the survey. While water chemistry parameters were not measured at the surveyed sites, cumulative impacts from poor land uses could be affecting the quality of the waterways. The presence of livestock facilities and logging operations within close proximity to some of the surveyed water bodies has most likely had a negative impact on stream quality through animal waste infiltration and sedimentation, respectively. It also should be noted that while we did not find any mussels and only 1 pea clam, we sampled a limited number of waterways in association with Thurmond Chatham Game Land. Additional efforts may lead to more positive results, but it is likely that the results reported herein are indicative of this area.

Table 2. Sphaeriid clam species found in Thurmond Chatham Game Land and associated waterways. See text for common names.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Sphaerium striatinum							
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson

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AQUATIC SNAILS

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Introduction

Freshwater snails (Mollusca: Gastropoda) are among the most ubiquitous organisms of shallow littoral zones in lakes and streams. Due to their behavior, widespread distribution, and commonly high abundance, snails serve a number of important roles in aquatic ecosystems. These include driving predator-prey interactions (Vermeij and Covich 1978, Lodge et al. 1987), serving as a dietary component to fish and wildlife, acting as water quality indicators, and most importantly, grazing on nuisance algae and detritus. However, freshwater snails are often overlooked in part due to their small size, perceived lack of charisma, cryptic habits, and the lack of readily available comprehensive guides for identification. As part of the inventory of aquatic animals associated with the state-owned Thurmond Chatham Game Land, we conducted field surveys of aquatic snails found in waterways occurring in and around the game land to better understand the taxonomy, distribution, and conservation needs of the taxa in North Carolina.

Life History

Much information about the reproductive cycles of freshwater snails has been ascertained due to the ease of laboratory rearing. From this information, 2 typical categories have been developed in which snails can be placed reproductively (Russell-Hunter 1978, Calow 1978). The first category includes annual adults that reproduce in the spring and die (semelparous). Most pulmonates (lung-breathing), which are oviparous hermaphrodites, belong to this group including the genera *Lymnaea* and *Physa*. The second category includes perennial adults that reproduce in both spring and late summer. Most prosobranchs (gill-breathing), which are dioecious and can be oviparous or ovoviviparous, belong to this group. These species are iteroparous and often live and reproduce for 4-5 years. Prosobranchs also are often sexually dimorphic, with females living longer than males (Brown et al. 1989).

Habitat and Food Requirements

Freshwater snails occur in a variety of habitat types, including both lentic (e.g., lakes, ponds, reservoirs) and lotic (e.g., rivers, streams, creeks) systems. Habitat preferences tend to be species specific, with well-documented substratum selection (Brown 1991). In general, silty habitats with slow-moving currents are colonized predominately by pulmonates or detritivorous prosobranchs, whereas limpets or prosobranch grazers colonize fast-current localities (Harman 1972). Many biotic and abiotic factors regulate the distribution of freshwater snails, with water hardness and pH considered to be the major determinants (Macan 1950, Pip 1986). However, it has been suggested that physiochemical factors such as calcium concentrations may only act to limit successful invasion of habitats with extreme levels of these factors (Lodge et al. 1987). Other factors such as dispersal ability and adequate substrata may play a more prominent role in snail distribution.

Freshwater snails are predominantly herbivores or detritivores, although they can ingest carrion (Bovbjerg 1968) or passively consume small invertebrates associated with periphyton (Cuker 1983a). Apparently, they prefer periphyton because it is easier to scrape than macrophytes, and it contains higher concentrations of nitrogen and other limiting nutrients (Russell-Hunter 1978, Aldridge 1983). Algae and diatoms also are prominent sources of nutrients for freshwater snails (Lodge 1986). While macrophytes are not the preferred source of nutrients for most freshwater snails, significant consumption can occur if snail densities reach high levels (Sheldon 1987).

Taxonomy, Distribution, and Statuses

Freshwater snails are divided into 2 groups – prosobranchs and pulmonates. Prosobranch snails are gill-breathing and have a calcareous plate called an operculum that seals the aperture when the snail withdraws into its shell. Pulmonate snails are lung-breathing and lack an operculum. Of the approximately 500 species recognized in North America, there are 49 genera and 349 species of prosobranch snails and 29 genera and 150 species of pulmonate snails (Burch 1982). While snails are widespread across the continent, they have reached their greatest abundance and diversity within the streams of the southeastern United States (Brown 1991). In North Carolina, there are approximately 52 species representing 10 families (Bogan 1997). Since very little work has been done to monitor freshwater snail populations, the current status of many species within North Carolina is undetermined. It is unknown as to magnitude of impact that anthropogenic effects such as siltation, riparian habitat destruction, impoundments, pollution, and hydrologic regime alteration have had on the state's snail fauna. Therefore, it is crucial that nongame biologists continue to gather information pertaining to these organisms so proper management plans can be implemented.

Methods

The aquatic snail survey of Thurmond Chatham Game Land was conducted during the fall of 1999. The game land, located in Wilkes and Alleghany counties, North Carolina, encompasses 6,231 acres. Refer to the Report Introduction for details on history of land use, drainage basin and waterway descriptions, and a map of all the sites that were surveyed. Waterways were accessed at bridge crossings or from roads running alongside rivers. We generally sampled upstream for an arbitrary distance (usually about 30 minutes of walking), until we felt that we had covered most habitat types present. Typical distances were 100 - 400 meters.

Freshwater snails were collected using a variety of techniques depending on the conditions of the site being surveyed (e.g., water depth, visibility, substrata types). The most common methods used to sample the snail fauna were visual searches and dip netting. The visual search basically involved examining rocky substrata, woody debris, vegetation, cans and bottles, and other items that snails might colonize. Dip netting involved running a 1/8-inch mesh dip net through vegetation and the substrata to collect snails. Other techniques used to collect snails included tactile searches and the use of a viewscope. Habitat preference, relative abundance, and recent reproduction for snail species were noted at each site. Snails were preserved in 70%-denatured alcohol and identified according to Burch (1989) and Basch (1963). Scientific names are according to Turgeon et al. (1998). Dr. Arthur E. Bogan, curator of aquatic invertebrates at the NC State Museum of Natural Sciences, verified some of the species identifications. Not all snails collected were preserved for obvious conservation and ethical reasons.

Results

Over 3 days from 19 to 21 October 1999, 31 sites were surveyed and aquatic snails were collected or observed at all 31 localities (Figure 2). Four species representing 3 families were documented during the Thurmond Chatham Game Land survey (Tables 3a and 3b). The relative abundance of each species varied, but by far, the most abundant and widespread species was *Elimia symmetrica*, with the snail residing at 28 sites. *Ferrissia* sp. was the next most abundant gastropod, residing at 20 sites. Due to species level variation and the uncertainty of positively discerning *Ferrissia* specimens, all specimens of this genus were identified as *Ferrissia* sp. Both of the aforementioned species ranged in abundance from rare to abundant, but overall they were common in the survey area. The remaining 2 snail species, *Leptoxis dilatata* and *Physella* sp., were represented at only 2 and 1 site, respectively. *Leptoxis dilatata* was uncommon to common at each site (#29 and #31, respectively) with a patchy distribution, while *Physella* sp. was rare at its lone site. Recent reproduction was seen at a number of sites for *E. symmetrica* and *Ferrissia* sp., a single site (#31) for *L. dilatata*, but was not evident for *Physella* sp.

Elimia symmetrica (symmetical elimia) was typically found on pebble, gravel, and cobble in Piedmont and mountain-like streams. On occasion, it also was found on woody debris. The symmetrical elimia was typically associated with moderate to fast flow, which limited its range to riffle-run stream reaches. This species was found in both the Yadkin-Pee Dee and New river basin portions of the survey, as well as in all 3 counties surveyed.

Ferrissia sp. was found over a wide array of substrata types, ranging from pebble, gravel, and cobble, to woody debris and detritus. Similarly, it was found in a variety of flow regimes, ranging from riffle-run to pool. Like the symmetrical elimia, this ancylid was found in both river basins and in each county surveyed.

Leptoxis dilatata (seep mudalia) was only collected from pebble, gravel, cobble, and bedrock substrata in riffle-run reaches. Over the surveyed area, this species was isolated to 2 sites in the Little River (New River Basin, Alleghany County).

Physella sp. (physa snail) was found in leaf packs at a single site in the Reddies River (Yadkin-Pee Dee River Basin, Wilkes County). The flow regime was slack to stagnant where these specimens were found, which is common for this species.

Discussion

Overall, the diversity and abundance of freshwater snails in the waterways associated with Thurmond Chatham Game Land appear to be low. In comparison to the aquatic survey of Stone Mountain State Park (McGrath 1996) where only *E. proxima* (= *E. symmetrica*, see below) and *Ferrissia* sp. were collected, this emphasizes the low diversity of the area. Moving northward, the diversity is somewhat greater in the New River Basin with at least 6 snail species present (McGrath 1998), but our survey area in this river basin adjacent to the game land only revealed 3 species. Further comparisons to other waterways within the Yadkin-Pee Dee and New river basins are limited due to a lack of recent surveys. The influence of geomorphologic and topographic factors has most likely structured the current gastropod fauna of the area. Major landscape scale factors such as these are known to influence and impact the distribution and

abundance of organisms over time, and it is possible that the area we surveyed has a naturally low diversity of aquatic snails. While water chemistry parameters were not measured at the surveyed sites, cumulative impacts from poor land uses could be affecting the quality of the waterways. The presence of livestock facilities and logging operations within close proximity to some of the surveyed water bodies has most likely had a negative impact on stream quality through animal waste infiltration and sedimentation, respectively. While these impacts may not have had a significant effect on the current aquatic snail diversity, they are likely affecting the current abundance and distribution of each species.

Taxonomic uncertainties within the freshwater snail fauna make the results here subject to revision. For example, the differentiation between *F. rivularis* and *F. fragilis* is difficult due to shell shape variation. Therefore, a common factor used to distinguish these species is the habitat they are collected in, with *F. rivularis* colonizing rivers and streams and *F. fragilis* inhabiting stagnant areas such as ditches, ponds, and backwater areas. All of the limpets identified in this survey were assigned to *Ferrissia* sp., but it is likely that at least both species inhabit some of the sites that were surveyed, with *F. rivularis* more dominant in the region. Likewise, there is uncertainty with the taxonomic assignments within the *Elimia* genera (Burch 1989). Typically, the specimens we collected would have been identified as *E. proxima* but it is thought that this species may be limited to the Tennessee River Basin (A.E. Bogan, NCSM, pers. comm.).

The collection of *Leptoxis dilatata* is of significance since this species is currently state-listed threatened due to its range restriction within the New River Basin (Adams 1990). While the seep mudalia is restricted to the New River Basin, McGrath (1998) noted that this species was abundant and widespread, so it appears to be healthy according to recent NCWRC survey data.

No other rare or significant snail species was found during the Thurmond Chatham Game Land aquatic inventory. However, much more research and status surveys are needed to determine which species are significant or rare on a state-wide basis. Current land management practices, including agriculture and urbanization, are having an effect on the snail fauna in North Carolina. As nongame biologists, we need to identify which species are at risk and identify ways to reduce or eliminate impacts.

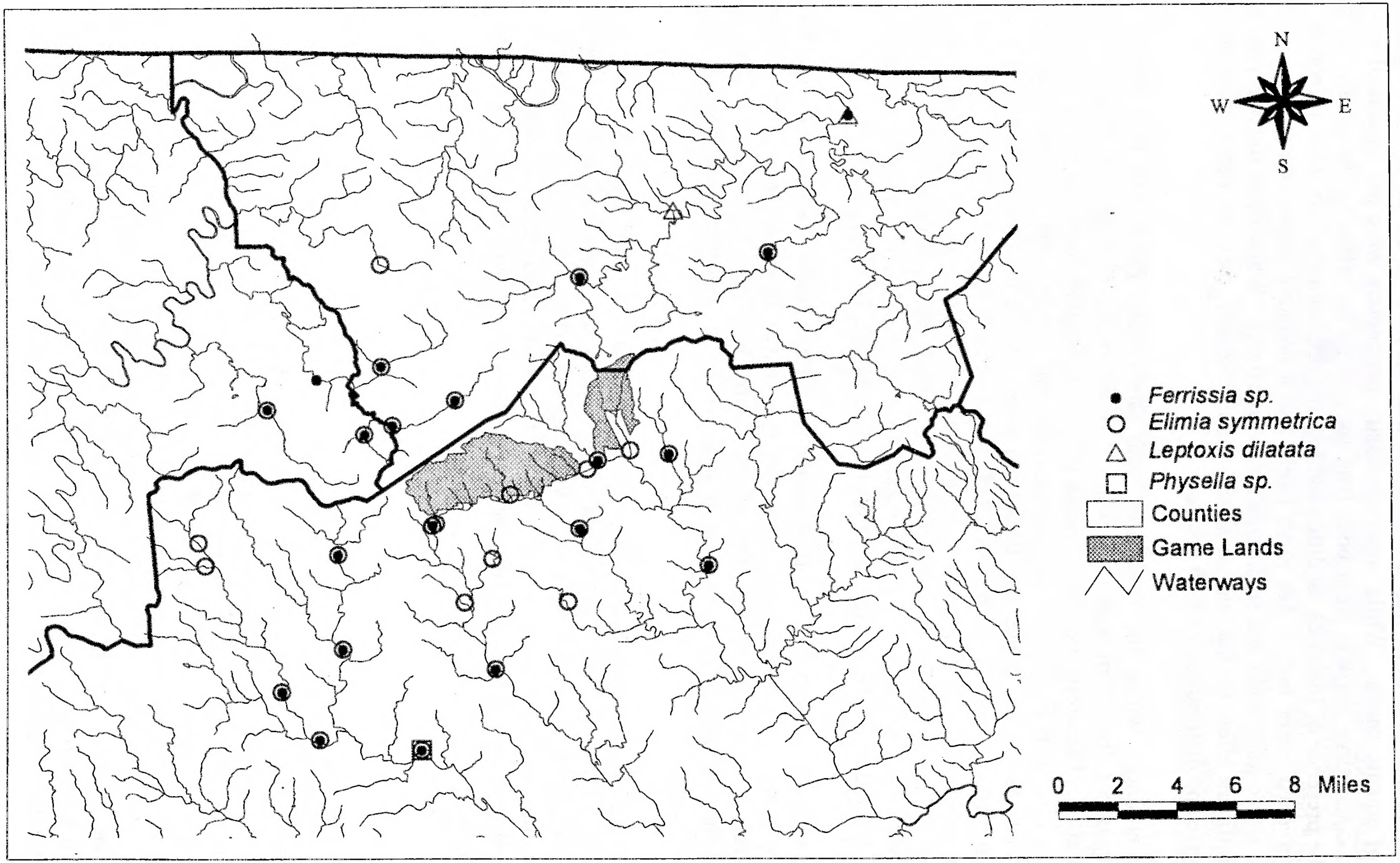

Figure 2. Map of sites indicating where each species of snail was collected in the Thurmond Chatham Game Land aquatic inventory, Wilkes, Ashe, and Alleghany counties, North Carolina, 1999.

Table 3a. Aquatic snail species found in Thurmond Chatham Game Land and associated waterways.

Prosobranchia	
Pleuroceridae	
Elimia symmetrica	symmetrical elimia
Leptoxis dilatata	seep mudalia
Pulmonata	
Ancylidae	
Ferrissia sp.	
Physidae	
Physella sp.	physa snail

Table 3b. Aquatic snail species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Elimia symmetrica							
991019.10btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Bowlin Creek	SR 1562	common	B.T. Watson
991019.11btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	patchy rare	B.T. Watson
991019.12btw	10/19/1999	Yadkin-Pee Dee	Wilkes	South Fork Reddies River	NC 16	patchy rare	B.T. Watson
991019.13btw	10/19/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	rare	B.T. Watson
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	uncommon	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Trib to Mulberry Creek	NC 18	common	B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	uncommon	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	uncommon	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	patchy uncommon	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	common	B.T. Watson
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	present	B.T. Watson
991019.9btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Roten Creek	SR 1564	common	B.T. Watson
991020.10btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Halls Creek	SR 1725	patchy common	B.T. Watson
991020.11btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	patchy rare	B.T. Watson
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	patchy uncommon	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	patchy uncommon	B.T. Watson
991020.3btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Lovelace Creek	SR 1730+	patchy uncommon	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	common	B.T. Watson
991020.5btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cook Branch	SR 1730	patchy uncommon	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	uncommon	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	present	B.T. Watson
991020.8btw	10/20/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	abundant	B.T. Watson
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Trib to West Prong Roaring River	SR 1725	common	B.T. Watson
991021.1btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	SR 1728	common	B.T. Watson
991021.2btw	10/21/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1501	uncommon	B.T. Watson
991021.3btw	10/21/1999	New	Ashe	Trib to South Fork New River	NC 88	rare	B.T. Watson
991021.4btw	10/21/1999	New	Alleghany	Glade Creek	SR 1422	rare	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	common	B.T. Watson

Table 3b (cont.). Aquatic snail species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
***Ferrissia* sp.**							
991019.11btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	patchy abundant	J.A. Johnson, B.T. Watson
991019.12btw	10/19/1999	Yadkin-Pee Dee	Wilkes	South Fork Reddies River	NC 16	patchy abundant	J.A. Johnson, B.T. Watson
991019.13btw	10/19/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	patchy abundant	J.A. Johnson
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	patchy abundant	J.A. Johnson, B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	patchy uncommon	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	abundant	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	patchy common	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	patchy uncommon	B.T. Watson
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	present	B.T. Watson
991020.11btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	abundant	J.A. Johnson
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	patchy common	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	patchy common	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	patchy uncommon	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	patchy common	J.A. Johnson, B.T. Watson
991020.8btw	10/20/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	common	J.A. Johnson
991021.2btw	10/21/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1501	patchy uncommon	J.A. Johnson
991021.3btw	10/21/1999	New	Ashe	Trib to South Fork New River	NC 88	rare	J.A. Johnson
991021.4btw	10/21/1999	New	Alleghany	Glade Creek	SR 1422	patchy rare	J.A. Johnson
991021.5btw	10/21/1999	New	Alleghany	Little River	NC 18 -	patchy uncommon	J.A. Johnson, B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	common	B.T. Watson
Leptoxis dilatata							
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	uncommon	A.E. Bogan, B.T. Watson
991021.5btw	10/21/1999	New	Alleghany	Little River	NC 18 -	patchy common	B.T. Watson, A.E. Bogan
***Physella* sp.**							
991020.11btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	patchy rare	J.A. Johnson

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CRAYFISHES

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Introduction

Crayfish play important roles in aquatic and sometimes terrestrial ecosystems, both as food sources for many animals and also as consumers of plant and animal material. Despite the magnitude of their ecological roles, we have much to learn about crayfish distributions, life histories, and taxonomy. As part of the inventory of aquatic animals associated with the state-owned Thurmond Chatham Game Land, we conducted field surveys of the crayfishes found in waterways occurring in and around the game land to contribute to our understanding of the distribution and status of crayfishes in North Carolina.

Reproduction and Life History

The crayfishes that occur in North Carolina (all members of the family Cambaridae) live for 2-3 years, on average (Hobbs III 1991, Taylor et al. 1996). Energy obtained from food consumption is allocated largely toward growth as juveniles and toward reproduction as adults (DiStefano 1993). Growth is accomplished through a series of exoskeletal molts (a process known as ecdysis), numbering from 5-10 until adulthood is reached, followed by only 1 (females) or 2 (males) molts per year on average throughout adulthood (Hobbs III 1991, DiStefano 1993). Male cambarid crayfishes exhibit cyclic dimorphism, alternating between a reproductively active form (form I) and a non-reproductive form (form II). Form I males can be present all year, but are usually most abundant during the fall and/or spring. Females carry fertilized eggs attached to their abdomens (a condition that is termed "in berry") for 2-20 weeks, depending on water temperatures. Once hatched, the juveniles are carried on the female until they molt into the 3rd instar (on average), after which they are free-living. Cambarid crayfishes breed more than once during their lives (Hobbs III 1991, DiStefano 1993).

Habitat Requirements and Preferences

Crayfish occur in lentic (e.g., lakes, ponds, marshes, ditches, backwaters of large rivers, groundwater) and lotic (e.g., streams, rivers, groundwater) aquatic habitats ranging from oligotrophic to hypereutrophic (Hobbs III 1991). Crayfish can be further classified as hypogean (below-ground dwellers) or epigean (above-ground dwellers). Hypogean crayfish spend much of their time in elaborate underground burrows associated with groundwater. These burrows can be in close proximity to a water body or stream, but can also be situated far from open water. Depending on the amount of time spent underground and the extent of tunnels created, burrowing crayfish are classified as primary, secondary, or tertiary burrowers (Hobbs III 1991). Generally, epigean crayfish occur in shallow (1-2 m) water, but can occur in deeper water, especially as adults. Juveniles are often found in littoral areas, where adequate shelter provides protection from predation and may mediate competition with adults. Crayfish actively forage at night, but seek shelter from predators during daylight in aquatic macrophytes, leaf litter, woody

debris, overhanging roots, cobble or large boulders, burrows or depressions, and in human debris (e.g., cans, tires) (Lodge and Hill 1994).

Crayfish are affected by both water and habitat quality. Changes in water quality that interfere with respiration (e.g., drastic temperature changes, acidification, pollution) can be detrimental to crayfish populations. Many crayfish are oxygen regulators and can survive changes in oxygen levels (Reiber 1995), but some are oxygen conformers and are less likely to successfully contend with these changes (Hobbs III 1991). Water pollution, caused by sources such as sewage, agricultural and urban runoff, acidification, and auto exhaust, can result in bioaccumulation of pesticides and trace heavy metals (e.g., lead, copper, cadmium). This can harm animals that consume crayfish in addition to directly causing negative effects on crayfish (e.g., mutation, reproductive failure, death) (Taylor et al. 1995, Daveikis and Alikhan 1996, Anderson et al. 1997, Zaranko et al. 1997). Habitat destruction can also negatively affect crayfish populations. Land use practices (e.g., agriculture, logging, and development) can alter habitat resulting in fewer areas available as shelter to crayfish (Smith et al. 1996, Richter et al. 1997). For example, siltation and runoff can decrease macrophyte (a source of food and shelter) availability, and channelization can alter stream bed sculpture.

Ecological Interactions

Crayfish are both directly and indirectly linked to the ecosystems in which they live. Because they are omnivorous (i.e., consume both plant and animal food, living or dead), and because they are consumed by animals from various trophic levels, crayfish form multiple links in aquatic and terrestrial food webs (Lodge et al. 1994, Charlebois and Lamberti 1996, Nystrom et al. 1996). Thus, crayfish are involved in the transfer of large amounts of energy in these systems. Crayfish process nutrients and make them available to other animals by (1) breaking down large material via shredding into smaller sizes, and (2) converting nutrients into biomass. Crayfish feed on aquatic vegetation (e.g., macrophytes, algae, periphyton), macroinvertebrates (e.g., aquatic insects, mollusks, small crustaceans), and small vertebrates (e.g., amphibians, small/juvenile fish). Crayfish also consume nonliving organic matter such as leaf litter or terrestrial animal carcasses from the riparian zone or shore and decaying aquatic plant and animal matter (Lodge and Hill 1994). Crayfish in turn are consumed by invertebrates (including other crayfish), fish, amphibians, reptiles, birds, and mammals (Lodge and Hill 1994). Crayfish perform an important role as a member of symbiosis with many invertebrates and as host to various aquatic parasites (Lodge and Hill 1994). Crayfish also experience competition, both between species and among different sizes of individuals within a population (Lodge and Hill 1994).

The introduction of non-indigenous crayfishes to areas currently occupied by native crayfishes can result in competition or even extirpation of natives and can have impacts on other components of the ecosystem (Charlebois and Lamberti 1996, Perry 1998). For example, if crayfish become too abundant, they can be destructive to aquatic ecosystems by destroying more macrophytes than they consume, resulting in less habitat and food for other animals (Lodge et al. 1994, Nystrom et al. 1996). In fact, Lodge et al. (2000) consider nonindigenous crayfish introductions to be the single greatest threat to native crayfish biodiversity worldwide.

Taxonomy, Distribution, and Statuses

In the United States and Canada, approximately 350 taxa of crayfish are recognized (Taylor et al. 1996, J.E. Cooper, NC State Museum of Natural Sciences, Curator of Crustaceans, pers. comm.). However, many species still await description (J.E. Cooper, NCSM, pers. comm.). For example, several current species are now recognized to be species complexes consisting of more than a single taxon. Conversely, animals grouped into several species or subspecies by different authors may actually belong to the same species. The greatest diversity of crayfishes occurs in the Southeast (Hobbs III 1991, Taylor et al. 1996), and North Carolina harbors at least 33 native (possibly up to 46) and 3 introduced species of *Cambarus, Procambarus, Orconectes,* and *Fallicambarus* (Cooper and Braswell 1995, J.E. Cooper, NCSM, pers. comm.). About half of the described crayfishes in North Carolina are of undetermined conservation status due to a lack of data on the distribution and abundance of these animals. Additionally, there are perhaps as many as a dozen native species yet to be described (J.E. Cooper, NCSM, pers. comm.). Of those species for which we have at least some information, the North Carolina Natural Heritage Program lists 10 species as significantly rare (LeGrand and Hall 1998), and the Scientific Council on Freshwater and Terrestrial Crustaceans proposes that 8 of North Carolina's species be of special concern, and that 13 species be put on a watch list (Clamp 1999). New information about current distributions has recently been reported (Cooper and Braswell 1995, Cooper et al. 1998). However, given that undescribed species exist and that we have much to learn about the distributions of crayfishes in North Carolina, it is imperative that we continue to improve our knowledge of crayfish by contributing to the growing database.

Methods

The crayfish survey of Thurmond Chatham Game Land was conducted during the fall of 1999. The game land, located in Wilkes and Alleghany counties, North Carolina, encompasses 6,231 acres. Refer to the Report Introduction for details on history of land use, drainage basin and waterway descriptions, and a map of all the sites that were surveyed. Waterways were accessed at bridge crossings or from roads running alongside rivers. We generally sampled upstream for an arbitrary distance (usually about 30 minutes of walking), until we felt that we had covered most habitat types present. Typical distances were 100 - 400 meters.

Crayfishes were collected using a number of different techniques, depending on the conditions of the waterway being sampled (e.g., substrate type, width/depth of water). We collected crayfishes by hand or with small or large dip nets after turning over or disturbing rocks under which they were hiding. We also sampled stream edges and leaf litter piles with large dip nets for juveniles and for species preferring slower habitats. Finally, we collected crayfishes by electrofishing while sampling for fishes. Electrofishing proved to be a less successful method for collecting crayfishes than visual location and dip netting. Collected specimens were preserved and stored in 70%-denatured ethanol.

Successful identification of many cambarid crayfishes usually requires collection of reproductive (form I) males. Certain features of their gonopods – the first pair of abdominal appendages, or pleopods – can be important in their taxonomy. Form I males can be distinguished from form II males by the advanced development of the terminal elements at the tips of their gonopods. In addition, form I males have highly developed hooks on the ischia of certain walking legs (pereiopods) that are used to hold the female during copulation. The size and shape of their

chelae may also vary at this stage. Some common characteristics used in identification of non-form I males are carapace length and depth/width ratio, areola width and length, presence and placement of spines, rostrum shape, color, and chela characteristics. Identification of crayfishes was accomplished through the use of taxonomic keys (Hobbs Jr. 1991, Jezerinac et al. 1995, Cooper 1998) and a checklist (Hobbs Jr. 1989), by comparing individuals to reference collection specimens (North Carolina Wildlife Resources Commission, and North Carolina State Museum of Natural Sciences), and via personal communication with Dr. J.E. Cooper. Common names are according to Clamp (1999). As our understanding of crayfish taxonomy continues to improve, the identifications of the species we collected may change.

In addition to identifying individuals, we noted approximate abundances of each type of crayfish collected, and quantified average carapace lengths of those collected (from the tip of the rostrum to the posterior carapace edge). We also looked for evidence of recent reproduction and estimated habitat preferences of each species based on the areas from which they were collected. We recorded presence/absence data for each species encountered at each site visited to allow a crude estimate of the distribution of each species within the waterways associated with the game lands. These data will also be added to a larger database describing statewide distributions. Where possible, we recorded notes on ecological interactions (e.g., abundance of food, presence of competitors or predators, quality of habitat). For logistical and ethical reasons, we did not preserve every crayfish collected.

Results

Over 5 days from 19 to 28 October 1999, 31 sites were inventoried. Crayfish were collected or observed at all sites surveyed (Figure 3 and Table 4a). Seven species were collected during the survey period: *Cambarus (Cambarus) bartonii* (Fabricius 1798), *Cambarus (Hiaticambarus) chasmodactylus* (James 1966), *Cambarus (H.) longulus* (Girard 1852), *Cambarus (Puncticambarus) robustus* (Girard 1852), *Cambarus (P.)* sp. C (a species complex related to *C. (P.) acuminatus* (Faxon 1884), and likely containing at least 2 species in this survey), a *Cambarus* species that we had a difficult time assigning even to a subgenus (referred to as only *Cambarus* sp.), and *Orconectes (Procericambarus) cristavarius* (Taylor 2000). See Table 4b for statistics on carapace lengths of each species collected.

Cambarus (C.) bartonii (Appalachian brook crayfish) was found in both the New and upper Yadkin-Pee Dee river basin portions of our survey. It was most commonly found hiding under rocks in fast flowing water. The size of crayfish collected was directly related to the size of rock it was found under, with larger crayfish preferring larger rocks. Juveniles were found along stream edges in leaf litter piles and backwater areas, but also under small rocks in the center of streams. This species was common in most waterways surveyed, and was especially abundant in larger streams or rivers. Juveniles were uncommon to common, and several form I males were collected. Thus, reproduction appeared to be ongoing. The taxonomic designation *C. (C.) bartonii* likely contains multiple species yet to be described. Most animals were chocolate brown to olive green in color without elaborate patterns, but animals collected from several sites that were assigned to this taxon closely resemble members of the *Jugicambarus* subgenus and were bright orange-red in color. Because of the difficulty in taxonomically distinguishing members of *C. (C.) bartonii* and *Cambarus (C.)* sp. A (Chattahoochee crayfish; a species that may be conspecific with *C. (C.) howardi* (Hobbs and Hall 1969)), it is possible that upon further

examination, some of these animals may turn out to be *C. (C.)* sp. A. However, the live color of these animals did not match the "typical" *C. (C.)* sp. A coloration patterns.

Cambarus (H.) chasmodactylus (New River crayfish) was common in the New River Basin. This species was also found hiding under rocks in fast flowing water. Larger rocks usually had larger crayfish under them. Some individuals were collected from slack areas. Juveniles were found along stream edges in leaf litter piles and backwater areas, but also under small rocks in the center of streams. This species was common in many waterways surveyed. Juveniles were present but not abundant, but most males were in form I. This suggests that this species was actively reproducing and the lack of juveniles collected may be seasonal. This is a very large species of crayfish, many of which were brightly colored with hues of light blue, green, orange, and brown, with reddish sutures. This species occurs on the proposed watch list (Clamp 1999).

Cambarus (H.) longulus (no common name available) was collected from the upper Yadkin-Pee Dee River Basin. It was not very widely distributed, but was generally common where it occurred. This species was also most often collected from under rocks in fast flowing water. Unlike *C. (H.) chasmodactylus*, this species is small. However, many form I males were present, indicating that reproduction was occurring. Juveniles, although present, were not common, but this may also be a seasonal effect. Coloration was generally rusty orange to brown.

Cambarus (P.) robustus (no common name available) was collected from the New River Basin, and was common throughout. This species was collected from both fast flowing water under rocks, and in slower areas along edges. Juveniles were common, and several form I males were collected, indicating that reproduction was ongoing. Coloration was generally a soft mottled saddle pattern in hues of brown.

Cambarus (P.) sp. C (no common name available) was collected from the upper Yadkin-Pee Dee River Basin, and was uncommon to common throughout. Individuals were collected from various types of habitat. Some were found under rocks in fast flowing water and some occupied areas of slower moving water where debris had accumulated. Juveniles were common, and several form I males were collected. Thus, these crayfish appeared to be reproducing.

There appear to be at least 2 forms of this species complex (possibly several different species). One form has strong double stripes on the dorsal side of its abdomen, as do *C. (P.) reburrus* (French Broad crayfish) – a species that is currently known to occur only in the French Broad and upper Savannah river basins – and *C. (Depressicambarus) latimanus* – a species known from the eastern Piedmont and Coastal Plain areas. Individuals with these markings have an acute sub-orbital angle, strong spines, a long acuminate rostrum, and wide, flat chelae. Individuals of this form were collected only from slow areas in leaf litter piles or along stream edges. The other form(s) is more characteristic of the "typical" *C. (P.)* sp. C, with a shorter and wider rostrum (nearly squarish in many individuals), narrower areola, and less strong spines (reduced to tubercles in some animals). These individuals were either dull or mottled in color, many with a saddle pattern. Individuals of this form were collected primarily from fast-flowing areas in stream centers, hiding under rocks. Further taxonomic investigation that is currently underway should clarify the identity of these 2 forms.

The crayfish assigned to *Cambarus* sp. contained characteristics of multiple subgenera, and we were unable to assign them to 1 subgenera at this time. These crayfish possessed strong cervical

tubercles or weak cervical spines, similar to crayfish from the *Puncticambarus* subgenus. However, the chelae of crayfish from the *Puncticambarus* subgenus usually have a double row of tubercles on the mesial margin of the palm. Many of these crayfish appeared to have a single row of appressed tubercles, similar to members of the *Cambarus* subgenus. However, members of the *Cambarus* subgenus usually do not possess cervical spines or tubercles. Further, the rostrum of these crayfish is similar to that of members from the *Hiaticambarus* subgenus, but could pass for a *Cambarus* subgenus rostrum. These individuals were either dull or mottled in color, many with a saddle pattern. Superficially, they resembled *C. (P.)* sp. C. Further taxonomic investigation that is currently underway should clarify the identity of these animals. This taxon was collected from only the Yadkin-Pee Dee portion of our survey. This taxon was not reported from collections in Stone Mountain State Park (a nearby area) by McGrath (1996), but has been recently collected in the region by NC Division of Water Quality personnel (J. E. Cooper, NCSM, pers. comm.).

Orconectes (P.) cristavarius (no common name available), was collected from the New River Basin. It was collected from only a few sites, and its abundance varied. At 2 sites, we collected only 1 individual, but at a third site, this species was common. Previous surveys in this area indicated that this species was common (McGrath 1998). These individuals were typically found hiding under rocks in fast flowing areas in the center of streams. Males were almost all in form I, and although not many juveniles were seen, reproduction was likely occurring. This species closely resembles *O. (P.) rusticus*, a non-native species recently discovered in the Broad River Basin. *O. (P.) cristavarius* can be recognized by its different coloration: It has a saddle pattern on its carapace that is trapezoidal in shape with straight edges, and contains a large reddish tubercle on the dorsal surface of its chelae as well as other yellowish and reddish tubercles. Its dorsal abdomen was generally dark with reddish sutures. Further, its rostrum has straight edges (vs. concave for *O. (P.) rusticus*), and the cutting edge of its mandibles are serrated (vs. straight for *O. (P.) rusticus*). For a comparison and the original description of *O. cristavarius*, see Taylor (2000). Prior to its description, this species was referred to as *O. (P.)* sp. B.

Discussion

The overall diversity of crayfishes in this system was high, likely because this survey encompassed parts of 2 river basins. In the upper Yadkin-Pee Dee River Basin, where two-thirds of our survey efforts was focused, *C. (C.) bartonii*, *C. (P.)* sp. C, and the unidentified *Cambarus* sp. were well distributed and common. Distribution of *C. (H.) longulus* was limited to fewer waterways, but was uncommon to common where they occurred. *C. (C.) bartonii*, and *C. (P.)* sp. C were fairly widespread, and occurred with most other species at sites where they were collected. The unidentified *Cambarus* sp. occurred either alone or with *C. (C.) bartonii*.. It may turn out to be a member of the *C. (P.)* sp. C complex. *C. (H.) longulus* was collected with both *C. (C.) bartonii* and *C. (P.)* sp. C.

In the New River Basin, where one-third of our survey efforts was focused, *C. (C.) bartonii, C. (H.) chasmodactylus*, and *C. (P.) robustus* were well distributed and common. *O. (P.) cristavarius* was less well distributed, occurring at only 3 waterways surveyed, and its abundance varied from rare at 2 sites to common at 1 site. At the site where it was common, it occurred with *C. (C.) bartonii* and *C. (P.) robustus*. All species were collected together at several sites, and combinations of 2 or 3 of the species occurred together at other sites.

Aspects of crayfish communities can tell us something about the system in which they occur. Although we did not directly test water quality, it was clear that the conditions in Thurmond Chatham Game Land were favorable to support crayfish (at least these species) in most of the waterways sampled. However, several individual crayfish (all *Cambarus* species) were deformed (rostrum, carapace, and chelae deformities). These deformities could be the result of poor water quality or they could be injuries from competition with other crayfish or from predator attacks. Current reproduction was evident for all species. Potential food sources (e.g., allochthonous and autochthonous organic debris, aquatic insects) were abundant, and vegetation was present, although it was not abundant during the season in which we sampled. Crayfishes were rarely seen away from cover. Predation pressure on these crayfishes (especially juveniles) was likely moderate because the fish community in this system was fairly healthy (see *Fish* section of this report). However, plenty of cover-providing habitat (mostly large rocks) was available to crayfishes and likely lessened direct impact by predation. It is unclear whether any of the less widespread species was limited by competition or by abiotic factors such as low dissolved oxygen or high acidity.

The nature and extent of this inventory of aquatic organisms did not allow us to perform rigorous quantitative sampling for crayfish. However, these data give us information on the distribution and relative abundance of the species encountered. In combination with previously collected data and known distributions, these data allow us to expand our knowledge of regional abundance and diversity. In so doing, we will be able to identify species that need some sort of protection and/or those that do not require protection as previously believed. We will also be able to identify waterways that have good crayfish populations but are in need of some measure of restoration in order to continue to provide adequate crayfish habitat. Alternatively, we may be able to identify waterways not currently containing crayfish that would provide suitable crayfish habitat if restored. In so doing, new habitat would be provided to other aquatic and riparian plants and animals. If crayfish are not collected from an area that should be suitable, we can begin to look for reasons precluding crayfish occurrence. Further, by providing collected specimens to the museum, we are contributing to our store of knowledge of North Carolina crayfishes.

We found 5 of the 7 species historically known to occur in the New River Basin, and 4 of the 11 species known to occur in the Yadkin-Pee Dee River Basin. Two species that we did not find, but that occur in both basins, are *C. (J.) asperimanus* and *C. (J.) dubius*. Both are burrowing species, and were likely not captured because our survey methods did not adequately address burrowers. The likelihood of finding a burrowing species in open water is greatest in spring, and our survey was conducted in the fall. *C. dubius* was collected from a nearby area in the Yadkin-Pee Dee River Basin (McGrath 1996). Other species not found in the Yadkin-Pee Dee River Basin are known to occur farther downstream and are not likely to occur as far up in the drainage basin as the areas we surveyed (e.g., *C. (D.) catagius, C.(D.) reduncus, C.(P.)* sp. nov.,.*P. (O.) acutus*, and an introduced species, *P. (S.) clarkii*). The unidentified *Cambarus* sp. animals that we collected may turn out to be one or more undescribed species. This survey has helped to further clarify distribution boundaries of several species in the New and upper Yadkin river basins.

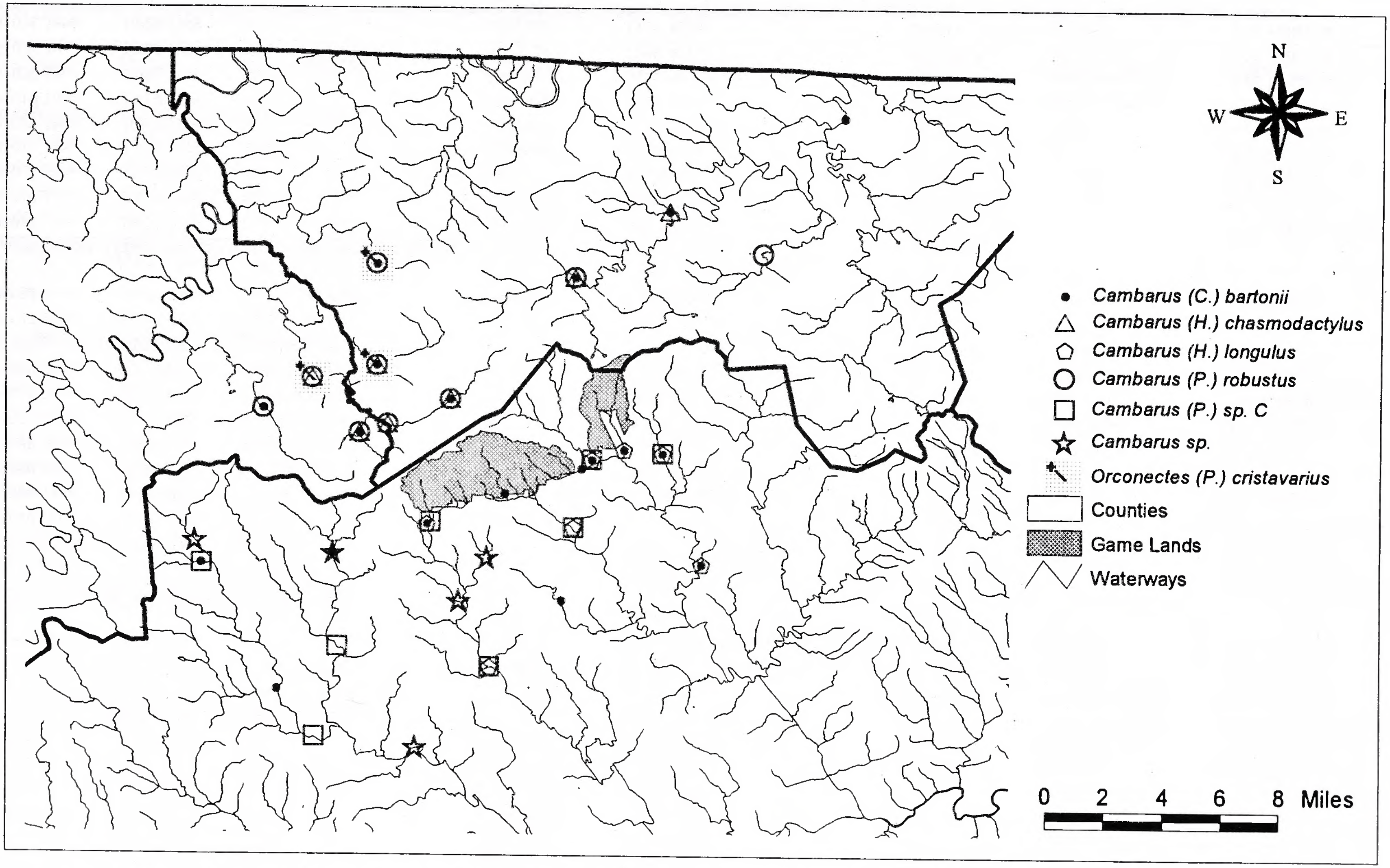

Figure 3. Map of sites indicating where each species of crayfish was collected in the Thurmond Chatham Game Land aquatic inventory, Wilkes, Ashe, and Alleghany counties, North Carolina, 1999.

Table 4a. Crayfishes found in Thurmond Chatham Game Land and associated waterways. See text for common names.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Cambarus (Cambarus) bartonii							
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	uncommon	A.H. Fullerton
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	rare	A.H. Fullerton
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	common	J.E. Cooper, A.H. Fullerton
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	rare	J.E. Cooper, A.H. Fullerton
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	rare	A.H. Fullerton
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	uncommon	A.H. Fullerton
991021.2btw	10/21/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1501	abundant	J.E. Cooper, A.H. Fullerton
991021.5btw	10/21/1999	New	Alleghany	Little River	NC 18	patchy uncommon	A.H. Fullerton
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	common	A.H. Fullerton
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	rare	A.H. Fullerton
Cambarus (Cambarus) cf. bartonii							
991019.10btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Bowlin Creek	SR 1562	patchy common	A.H. Fullerton
991019.11btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	patchy uncommon	A.H. Fullerton
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	common	J.E. Cooper, A.H. Fullerton
991020.3btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Lovelace Creek	SR 1730+	common	A.H. Fullerton
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	common	A.H. Fullerton
991020.5btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cook Branch	SR 1730	uncommon	A.H. Fullerton
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	common	A.H. Fullerton
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	rare	A.H. Fullerton
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Trib to West Prong Roaring River	SR 1725	common	A.H. Fullerton
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	abundant	A.H. Fullerton
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	common	A.H. Fullerton
991028.2btw	10/28/1999	Yadkin-Pee Dee	Wilkes	Bowlin Creek	SR 1562	common	A.H. Fullerton
Cambarus (Hiaticambarus) chasmodactylus							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	common	J.E. Cooper, A.H. Fullerton
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	rare	A.H. Fullerton
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	abundant	A.H. Fullerton
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	rare	A.H. Fullerton
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21	common	A.H. Fullerton
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	uncommon	A.H. Fullerton
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	uncommon	A.H. Fullerton
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	rare	A.H. Fullerton
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	present	A.H. Fullerton

Table 4a (cont.). Crayfishes found in Thurmond Chatham Game Land and associated waterways. See text for common names.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Cambarus (Hiaticambarus) longulus							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18	patchy uncommon	A.H. Fullerton
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	abundant	A.H. Fullerton
991020.3btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Lovelace Creek	SR 1730+	common	A.H. Fullerton
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	common	A.H. Fullerton
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	rare	A.H. Fullerton
991020.8btw	10/20/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	patchy uncommon	J.E. Cooper, A.H. Fullerton
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	common	A.H. Fullerton
***Cambarus (Puncticambarus)* sp. C**							
991019.10btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Bowlin Creek	SR 1562	present	A.H. Fullerton
991019.12btw	10/19/1999	Yadkin-Pee Dee	Wilkes	South Fork Reddies River	NC 16	patchy uncommon	J.E. Cooper, A.H. Fullerton
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18	patchy uncommon	A.H. Fullerton
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	rare	A.H. Fullerton
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	rare	A.H. Fullerton
991021.1btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	SR 1728	patchy common	A.H. Fullerton
***Cambarus (Puncticambarus)* cf. sp. C**							
991019.13btw	10/19/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	patchy common	A.H. Fullerton
991020.8btw	10/20/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	patchy uncommon	J.E. Cooper, A.H. Fullerton
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	South Fork Reddies River	NC 16	rare	A.H. Fullerton
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	uncommon	A.H. Fullerton
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	rare	A.H. Fullerton
Cambarus (Puncticambarus) robustus							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	uncommon	J.E. Cooper, A.H. Fullerton
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	common	A.H. Fullerton
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	uncommon	A.H. Fullerton
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	common	A.H. Fullerton
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	rare	A.H. Fullerton
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	rare	A.H. Fullerton
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	uncommon	A.H. Fullerton
991021.4btw	10/21/1999	New	Alleghany	Glade Creek	SR 1422	rare	A.H. Fullerton
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	rare	A.H. Fullerton
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	rare	A.H. Fullerton

Table 4a (cont.). Crayfishes found in Thurmond Chatham Game Land and associated waterways. See text for common names.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
***Cambarus* sp.**							
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Trib to Mulberry Creek	NC 18	patchy uncommon	A.H. Fullerton
991019.9btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Roten Creek	SR 1564	common	A.H. Fullerton
991020.10btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Halls Creek	SR 1725	abundant	A.H. Fullerton
991021.2btw	10/21/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1501	abundant	J.E. Cooper, A.H. Fullerton
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	common	A.H. Fullerton
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	A.H. Fullerton
Orconectes (Procericambarus) cristavarius							
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	common	J.E. Cooper, A.H. Fullerton
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	rare	A.H. Fullerton
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	rare	A.H. Fullerton

Table 4b. Statistics on carapace lengths (mm) of crayfishes found in Thurmond Chatham Game Land and associated waterways. See text for common names.

	Avg	Std	Min	Max
Cambarus (Cambarus) bartonii	**Avg**	**Std**	**Min**	**Max**
female (19 records)	23.3	4.7	14.0	29.0
male I (2 records)	24.8	3.2	22.5	27.0
male II (10 records)	23.7	7.1	14.0	32.5
Species Total (31 records)	23.6	5.4	14.0	32.5
Cambarus (Cambarus) cf. *bartonii*	**Avg**	**Std**	**Min**	**Max**
female (31 records)	23.8	8.9	7.5	43.0
male I (3 records)	30.7	4.5	26.5	35.5
male II (18 records)	22.9	8.2	10.0	41.0
Species Total (52 records)	23.9	8.6	7.5	43.0
Cambarus (Hiaticambarus) chasmodactylus	**Avg**	**Std**	**Min**	**Max**
female (12 records)	35.7	8.8	20.0	47.0
male I (5 records)	38.3	4.4	35.5	46.0
male II (11 records)	30.6	9.4	15.5	45.0
Species Total (28 records)	34.2	8.7	15.5	47.0
Cambarus (Hiaticambarus) longulus	**Avg**	**Std**	**Min**	**Max**
female (18 records)	23.6	2.9	18.0	27.5
male I (13 records)	23.9	3.0	18.5	29.0
male II (2 records)	19.0	1.4	18.0	20.0
Species Total (33 records)	23.4	3.0	18.0	29.0
Cambarus (Puncticambarus) sp. C	**Avg**	**Std**	**Min**	**Max**
female (12 records)	23.0	9.3	9.0	43.0
male I (1 record)	41.0		41.0	41.0
male II (13 records)	19.7	10.5	11.0	42.5
Species Total (26 records)	22.0	10.4	9.0	43.0
Cambarus (Puncticambarus) cf. sp. C	**Avg**	**Std**	**Min**	**Max**
female (7 records)	23.2	10.8	10.5	38.5
male II (6 records)	22.5	6.7	13.5	30.0
Species Total (13 records)	22.9	8.8	10.5	38.5

Table 4b (cont.). Statistics on carapace lengths (mm) of crayfishes found in Thurmond Chatham Game Land and associated waterways. See text for common names.

	Avg	Std	Min	Max
Cambarus (Puncticambarus) robustus	Avg	Std	Min	Max
female (24 records)	23.6	9.7	8.5	44.0
male I (2 records)	38.3	6.7	33.5	43.0
male II (7 records)	22.6	7.5	10.0	33.0
Species Total (33 records)	24.3	9.7	8.5	44.0
Cambarus sp.	Avg	Std	Min	Max
female (28 records)	23.3	6.6	11.0	37.5
male I (3 records)	33.8	2.3	32.5	36.5
male II (19 records)	20.6	5.7	9.0	31.5
Species Total (50 records)	22.9	6.8	9.0	37.5
Orconectes (Procericambarus) cristavarius	Avg	Std	Min	Max
female (8 records)	23.8	4.8	17.5	33.0
male I (4 records)	22.3	1.9	20.0	24.5
Species Total (12 records)	23.3	4.0	17.5	33.0

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FRESHWATER FISHES

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Introduction

Fishes are the most numerous and diverse of the major vertebrate groups. Their various morphological, behavioral, reproductive, and physiological adaptations have allowed them to dominate the waters of the world. Fishes can be found in a broad array of habitats, including vernal pools, mountain streams, and the ocean floor. Their dominance is reflected in the number of living species. Over 24,600 species have been described (Moyle and Cech 1996), and it is believed that this number may increase to approximately 28,500 (Nelson 1994). The North American continent harbors approximately 1,100 species of freshwater fish (Burr and Mayden 1992), with 790 (75%) species occurring in the United States (Page and Burr 1991). More than 225 species can be found in North Carolina (Menhinick 1991).

While most of the attention from the public and fisheries biologists is directed towards the game fishes, these species make up only about 5% of the freshwater fish fauna in the United States. The remaining 95% are little known, but charismatic, nongame species, such as darters and minnows. Nongame fishes play a vital role in the balance of aquatic ecosystems. Their diets are diverse, and, in turn, they serve as dietary components for sport fishes, water birds, and other wildlife. They also are important indicators of water quality and can signal when aquatic ecosystems are being negatively impacted. Game fishes also are important components of aquatic ecosystems and provide a source of recreation and employment for many people. Unfortunately, in 1989, the American Fisheries Society regarded 364 North American freshwater fish species as endangered, threatened, or special concern, an increase of 45% in just 10 years (Williams et al. 1989). This number represents approximately one-third of the North American native freshwater fish fauna. In North Carolina, approximately 25% of the freshwater fishes are state listed. Some of the reasons for this decline include habitat alteration and loss, chemical pollution, overexploitation, and introduction of exotic species. Given this information, it is essential that we better understand the taxonomy, distribution, and conservation needs of the various taxa. Therefore, a freshwater fish inventory of the waterways associated with the state-owned Thurmond Chatham Game Land was initiated to ascertain some of this needed information.

Methods

The freshwater fish survey of Thurmond Chatham Game Land was conducted during the fall of 1999. The game land, located in Wilkes and Alleghany counties, North Carolina, encompasses 6,231 acres. Refer to the Report Introduction for details on history of land use, drainage basin and waterway descriptions, and a map of all the sites that were surveyed. Waterways were accessed at bridge crossings or from roads running alongside rivers. We generally sampled upstream for an arbitrary distance (usually about 30 minutes of walking), until we felt that we had covered most habitat types present. Typical distances were 100 - 400 meters.

Freshwater fishes were collected using a variety of techniques depending on the conditions of the site being surveyed (e.g., water depth, visibility, substrata types). The most common method used was backpack electrofishing (23 of 31 sites). This method was chosen because it is more comprehensive and efficient than other methods used to collect fishes in streams. The other commonly used technique incorporated into the survey included the use of dip nets. Most fishes collected were identified to species and released unharmed. However, it was necessary to perform some of the identifications in the laboratory. This was carried out by fixing the fish in 10% formalin and preserving them in 70% ethanol. Once the fishes were preserved, they were identified with the use of a compound microscope (Nikon). Fishes were identified according to Menhinick (1991), Page and Burr (1991), Rhode et al. (1994), and Jenkins and Burkhead (1994). Dr. Wayne C. Starnes and others (G.M. Hogue, T.L. Fullbright, and Dr. M.E. Raney) from the NC State Museum of Natural Sciences verified some of the identifications. Besides presence-absence data, relative abundance and recent reproduction information were noted for each species to determine population health.

Results

Over 5 days from 19 to 28 October 1999, 31 sites were surveyed and fish were collected or observed at 30 of these localities (Figure 4). Twenty-eight species representing 7 families were documented during the survey of Thurmond Chatham Game Land (Tables 5a and 5b). Of the 55 species that have been documented in the vicinity of the survey area within Wilkes, Alleghany, and Ashe counties (Menhinick 1991), we confirmed the presence of only 27 of these species. Limitations as to our access of all available habitats and sampling range within the 3 counties were the most likely reasons for the absence of particular species. However, we did note the presence of *Scartomyzon rupiscartes* (striped jumprock), which is the first record of this species in Wilkes County (Menhinick 1991). Overall, abundance, distribution, and recent reproduction were low to moderate for most species encountered.

A number of surveyed sites resulted in the collection of trout parr. As parr, trout can be very difficult to identify without sacrificing them for laboratory identification. Since the area is commonly stocked with trout, and this is a popular sport fish, we decided against preserving specimens for identification. Therefore, we identified collected specimens as trout parr. Likewise, we observed adult trout at 2 localities while backpack electrofishing. However, we were unable to net them so a positive identification could not be made and they were noted in our records as trout.

Discussion

The waterways associated with Thurmond Chatham Game Land contain a moderate diversity and distribution of fish species. While some of the fish species were collected at isolated locations (e.g., *Cyprinella labrosa*, *Notropis hudsonius*, and *Percina crassa*), the majority tended to occur over a moderate to broad area. The species abundance tended to vary among sites, with the cyprinids comprising the majority of the biomass at most of the sites. The moderate distribution and abundance of a majority of the species has probably been aided by the relative lack of impacts on the waterways in the area. Overall, the area we surveyed was mostly rural and undeveloped, minimizing the effects of agriculture and urbanization. Compared to other

surveys of the area, we appear to have collected a representative sample of the fish fauna. Simon (1996) reported that 11 fish species occur in the Thurmond Chatham Game Land. We indicated the presence of at least 9 of these species (depending on the actual identification of the trout parr). Likewise, 14 species of fish have been collected within the Stone Mountain State Park (McGrath 1996), of which we documented at least 11 of these species. In addition, McGrath (1998) reported the presence of at least 27 fish species associated with the New River State Park, 14 of which also were collected in our survey.

Scartomyzon rupiscartes was documented during this survey, which had not previously been shown to extend into the Wilkes County portion of the Yadkin-Pee Dee River Basin (Menhinick 1991). Given the close proximity of the range of this species to Wilkes County, it was not surprising to collect these individuals. However, the number of sites from which the species was collected (7) was unexpected. In addition, the Kanawha darter (*Etheostoma kanawhae*) was documented at 4 sites. This species is currently considered "significantly rare" by the North Carolina Natural Heritage Program.

While no threatened or endangered fish species were collected during the survey of Thurmond Chatham Game Land, continual research and status surveys are needed in order to determine the present status of each species. Current land management practices, including agriculture and urbanization, are having an effect on the fish fauna in North Carolina. As nongame biologists, we need to identify which species are at risk and identify ways to reduce or eliminate the impacts.

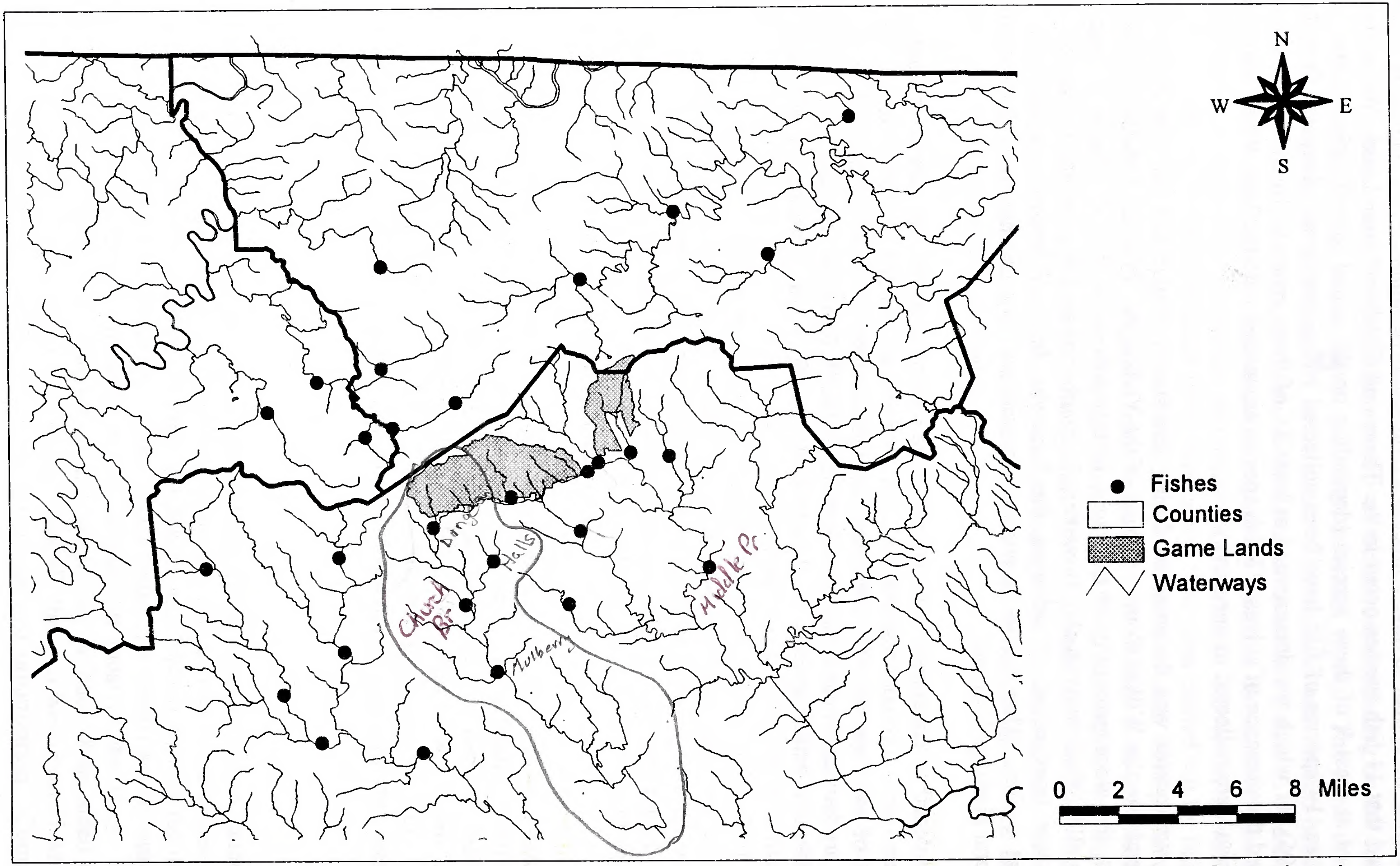

Figure 4. Map of sites indicating where freshwater fishes were collected in the Thurmond Chatham Game Land aquatic inventory, Wilkes, Ashe, and Alleghany counties, North Carolina, 1999.

Table 5a. Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Catostomidae	
Catostomus commersoni	white sucker
Hypentelium nigricans	northern hogsucker
Scartomyzon rupiscartes	striped jumprock
Centrarchidae	
Ambloplites rupestris	rock bass
Lepomis auritus	redbreast sunfish
Micropterus dolomieu	smallmouth bass
~~Cottidae~~	
~~*Cottus bairdi*~~	~~mottled sculpin~~, deleted. 10/2010
Cyprinidae	
Campostoma anomalum	central stoneroller
Clinostomus funduloides	rosyside dace
Cyprinella labrosa	thicklip shiner
Cyprinella pyrrhomelas	fieryblack shiner
Cyprinella spiloptera	spotfin shiner
Hybopsis hypsinotus	highback chub
Nocomis leptocephalus	bluehead chub
Notropis chiliticus	redlip shiner
Notropis hudsonius	spottail shiner
Notropis scabriceps	New River shiner
Phoxinus oreas	mountain redbelly dace
Rhinichthys atratulus	blacknose dace
Rhinichthys cataractae	longnose dace
Semotilus atromaculatus	creek chub
Ictaluridae	
Noturus insignis	margined madtom
Percidae	
Etheostoma flabellare	fantail darter
Etheostoma kanawhae	Kanawha darter
Etheostoma olmstedi	tesselated darter
Percina crassa	piedmont darter
Percina gymnocephala	Appalachia darter
Salmonidae	
Salmo trutta	brown trout

Table 5b. Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Ambloplites rupestris							
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	rare	B.T. Watson
991028.7btw	10/28/1999	New	Alleghany	Little River	NC 18	present	B.T. Watson
Campostoma anomalum							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	rare	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	uncommon	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	common	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	uncommon	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	common	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	common	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	uncommon	B.T. Watson
Catostomus commersoni							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	rare	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br	NC 18	rare	B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	uncommon	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	rare	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	rare	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	rare	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	uncommon	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	patchy common	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	uncommon	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	patchy common	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	uncommon	B.T. Watson
Clinostomus funduloides							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	uncommon	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br	NC 18	uncommon	B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	uncommon	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	GL Rd-	present	B.T. Watson

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Clinostomus funduloides							
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	uncommon	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	rare	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson
991020.3btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Lovelace Creek	SR 1730+	present	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	common	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	common	B.T. Watson
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cave Cr. ~~Trib to West Prong Roaring River~~	SR 1725	common	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	common	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	abundant	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	uncommon	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	uncommon	B.T. Watson
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	patchy common	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	patchy uncommon	B.T. Watson
Cottus bairdi							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	abundant	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	present	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	abundant	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	present	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	present	B.T. Watson
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	common	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	present	B.T. Watson
991021.3btw	10/21/1999	New	Ashe	Trib to South Fork New River	NC 88	abundant	J.M. Alderman
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	common	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	patchy uncommon	B.T. Watson
Cyprinella labrosa							
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	rare	B.T. Watson

no voucher data entry error; no such record deleted Oct. 2010

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Cyprinella pyrrhomelas							
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	common	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	uncommon	B.T. Watson
Cyprinella spiloptera							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	rare	W.C. Starnes
Etheostoma flabellare							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	abundant	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	present	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	common	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	present	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	present	B.T. Watson
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	present	B.T. Watson
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	uncommon	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	uncommon	B.T. Watson
991020.3btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Lovelace Creek	SR 1730+	present	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.5btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cook Branch	SR 1730	present	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	uncommon	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	rare	B.T. Watson
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cane Cr. ~~Trib to West Prong Roaring River~~	SR 1725	uncommon	B.T. Watson
991021.1btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	SR 1728	present	B.T. Watson ?
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	uncommon	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	rare	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	rare	B.T. Watson
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	common	B.T. Watson
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	uncommon	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	rare	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	uncommon	B.T. Watson

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Etheostoma kanawhae							
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	present	B.T. Watson, W.C. Starnes
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	rare	B.T. Watson
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson, W.C. Starnes
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	common	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson
Etheostoma olmstedi							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	uncommon	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br	NC 18	rare	B.T. Watson
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21	present	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	rare	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	common	B.T. Watson
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	uncommon	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	rare	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	patchy uncommon	B.T. Watson
991028.7btw	10/28/1999	New	Alleghany	Little River	NC 18	uncommon	B.T. Watson
Hybopsis hypsinotus							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	rare	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br	NC 18	uncommon	B.T. Watson, W.C. Starnes
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	uncommon	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	rare	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	patchy common	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	rare	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	uncommon	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	rare	B.T. Watson

no record @NCSM 02/18/2009

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Hypentelium nigricans							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	patchy common	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	uncommon	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	present	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	rare	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	common	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	patchy common	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	common	B.T. Watson
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	uncommon	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	common	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	common	B.T. Watson
Lepomis auritus							
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	rare	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	uncommon	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	rare	B.T. Watson
Micropterus dolomieu							
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br	NC 18	rare	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	rare	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	uncommon	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	abundant	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	common	B.T. Watson
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	present	B.T. Watson
Nocomis leptocephalus							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	common	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Trib to Mulberry Creek	NC 18	common	B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	common	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	common	B.T. Watson
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	present	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	common	B.T. Watson
991020.3btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Lovelace Creek	SR 1730+	present	B.T. Watson

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Nocomis leptocephalus							
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.5btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cook Branch	SR 1730	present	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	common	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	common	B.T. Watson
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cane Cr. ~~Trib to West Prong Roaring River~~	SR 1725	common	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	common	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	common	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	common	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	common	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	common	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	common	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	common	B.T. Watson
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	uncommon	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	common	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	common	B.T. Watson
Notropis chiliticus							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	common	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br	NC 18	common	B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	common	B.T. Watson
991019.3btw	10/19/1999	New	Ashe.	Cranberry Creek	NC 88-	common	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	common	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	common	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	common	B.T. Watson
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cane Cr. ~~Trib to West Prong Roaring River~~	SR 1725	common	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	common	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	common	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	uncommon	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	uncommon	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	common	B.T. Watson

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Notropis chiliticus							
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	common	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	common	B.T. Watson
Notropis hudsonius							
991028.7btw	10/28/1999	New	Alleghany	Little River	NC 18	present	B.T. Watson
Notropis scabriceps							
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	rare	B.T. Watson, W.C. Starnes
Noturus insignis							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	uncommon	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br.	NC 18	uncommon	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	common	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	common	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	B.T. Watson
991027.7btw	10/27/1999	Yadkin-Pee Dee	Wilkes	~~South Fork~~ Reddies River	NC 16	uncommon	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	common	B.T. Watson
991027.9btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1567	common	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	rare	B.T. Watson
Percina crassa							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	rare	B.T. Watson, W.C. Starnes
Percina gymnocephala							
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	present	B.T. Watson, W.C. Starnes
991019.6btw	10/19/1999	New	Alleghany	Little River	US 21+	present	B.T. Watson, W.C. Starnes

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Phoxinus oreas							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	common	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	present	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	rare	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson
991019.7btw	10/19/1999	New	Alleghany	Little River	SR 1193-	present	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	abundant	B.T. Watson
Rhinichthys atratulus							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	common	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY-	present	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	common	B.T. Watson
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	common	B.T. Watson
991019.5btw	10/19/1999	New	Alleghany	Prathers Creek	SR 1149+	present	B.T. Watson
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	uncommon	B.T. Watson
991027.8btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Middle Fork Reddies River	SR 1559	rare	B.T. Watson
991028.2btw	10/28/1999	Yadkin-Pee Dee	Wilkes	Bowlin Creek	SR 1562	common	B.T. Watson
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	common	B.T. Watson
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	rare	B.T. Watson
Rhinichthys cataractae							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	uncommon	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	rare	B.T. Watson
Salmo trutta							
991020.10btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Halls Creek	SR 1725	common	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	rare	B.T. Watson
991028.5btw	10/28/1999	New	Alleghany	Little River	US 21+	uncommon	B.T. Watson

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
Scartomyzon rupiscartes							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	patchy common	W.C. Starnes, B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church BR.	NC 18	present	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	uncommon	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	patchy common	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	rare	B.T. Watson
991028.1btw	10/28/1999	Yadkin-Pee Dee	Wilkes	West Prong Roaring River	SR 1730	patchy common	B.T. Watson
Semotilus atromaculatus							
991019.14btw	10/19/1999	Yadkin-Pee Dee	Wilkes	Mulberry Creek	NC 18-	rare	B.T. Watson
991019.15btw	10/19/1999	Yadkin-Pee Dee	Wilkes	~~Trib to Mulberry Creek~~ Church Br.	NC 18	rare	B.T. Watson
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	present	B.T. Watson
991019.2btw	10/19/1999	New	Ashe	Laurel Fork	BR PKWY	present	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	rare	B.T. Watson
991020.4btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Harris Creek	SR 1736+	present	B.T. Watson
991020.5btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cook Branch	SR 1730	present	B.T. Watson
991020.6btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Pike Creek	GL Rd+/-	uncommon	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	uncommon	B.T. Watson
991020.9btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Cane Creek ~~Trib to West Prong Roaring River~~	SR 1725	uncommon	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	uncommon	B.T. Watson
991027.6btw	10/27/1999	Yadkin-Pee Dee	Wilkes	Reddies River	SR 1546	rare	B.T. Watson
991028.2btw	10/28/1999	Yadkin-Pee Dee	Wilkes	Bowlin Creek	SR 1562	rare	B.T. Watson
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	common	B.T. Watson
trout							
991019.4btw	10/19/1999	New	Alleghany	Piney Fork	SR 1143-	present	B.T. Watson
991020.7btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Middle Prong Roaring River	SR 1736	present	B.T. Watson

Table 5b (cont.). Freshwater fish species found in Thurmond Chatham Game Land and associated waterways.

Site No.	Date	River Basin	County	Waterway	Road No.	Abundance	Identified By
trout parr							
991019.1btw	10/19/1999	New	Alleghany/Ashe	Meadow Fork	NC 18-	present	B.T. Watson
991019.3btw	10/19/1999	New	Ashe	Cranberry Creek	NC 88-	present	B.T. Watson
991020.1btw	10/20/1999	New	Alleghany	Meadow Fork	SR 1143+	rare	B.T. Watson
991020.2btw	10/20/1999	Yadkin-Pee Dee	Wilkes	Basin Creek	SR 1730+/-	present	B.T. Watson
991021.6btw	10/21/1999	Yadkin-Pee Dee	Wilkes	Dungeon Creek	SR 1730	present	B.T. Watson
991027.10btw	10/27/1999	Yadkin-Pee Dee	Wilkes	North Fork Reddies River	SR 1575	rare	B.T. Watson
991028.3btw	10/28/1999	New	Ashe	Trib to South Fork New River	NC 88	rare	B.T. Watson
991028.4btw	10/28/1999	New	Alleghany	Little River	SR 1193	common	B.T. Watson
991028.6btw	10/28/1999	New	Alleghany	Glade Creek	SR 1422	rare	B.T. Watson

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